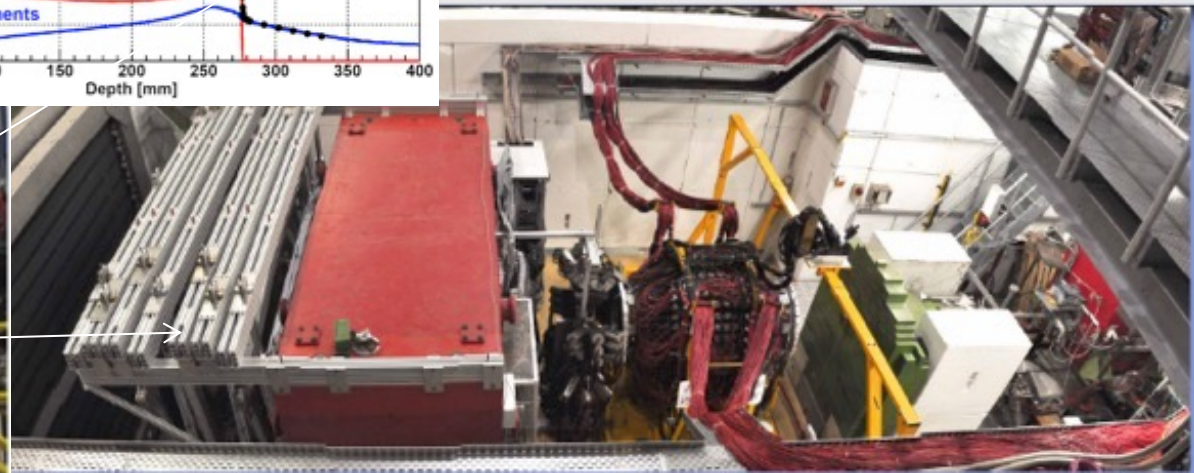
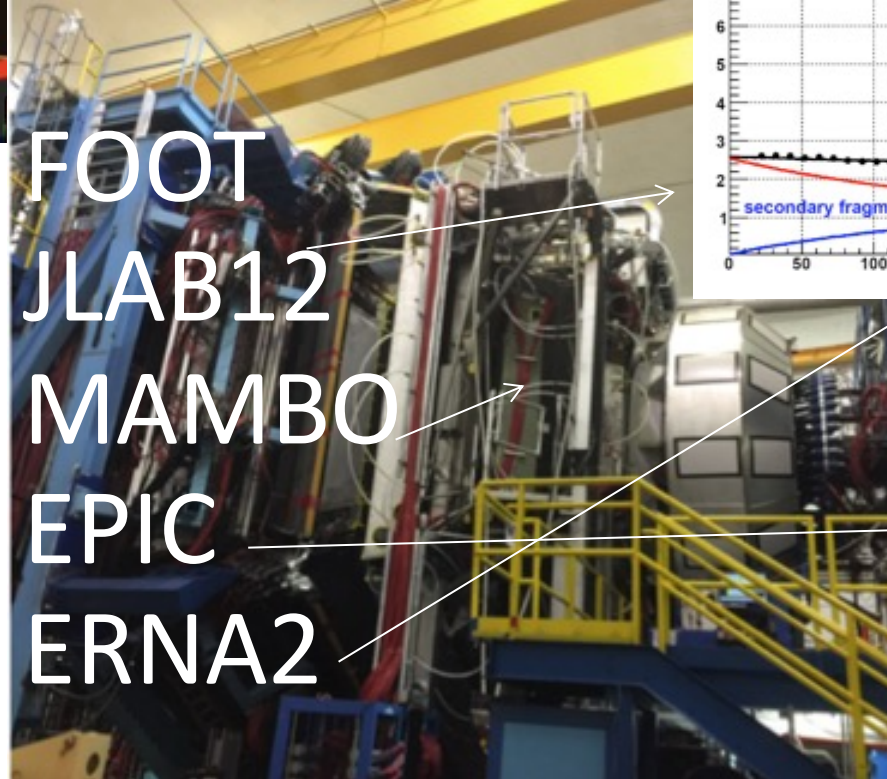
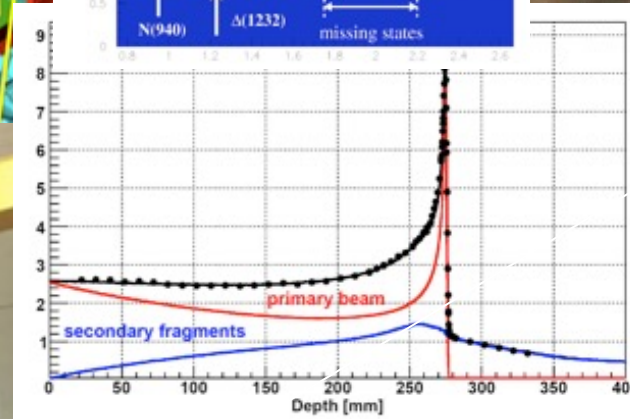
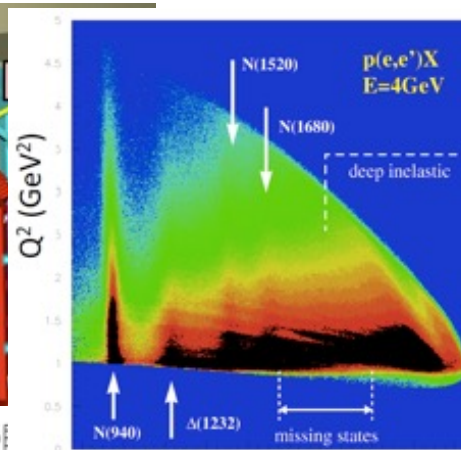
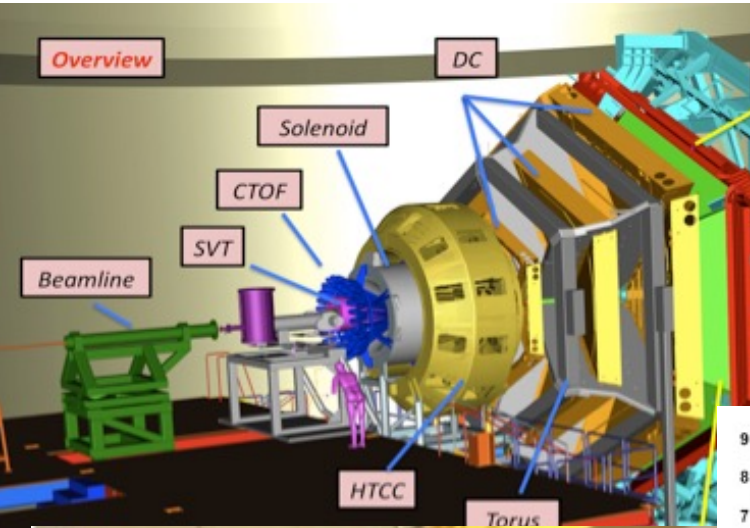


Gruppo III Roma Tor Vergata



MAMBO

MAMBO (MAMi-BOnn)

La sigla MAMBO si articola su due attività:

BGOOD a ELSA (Bonn)

□ Coinvolgimento della sezione TOV

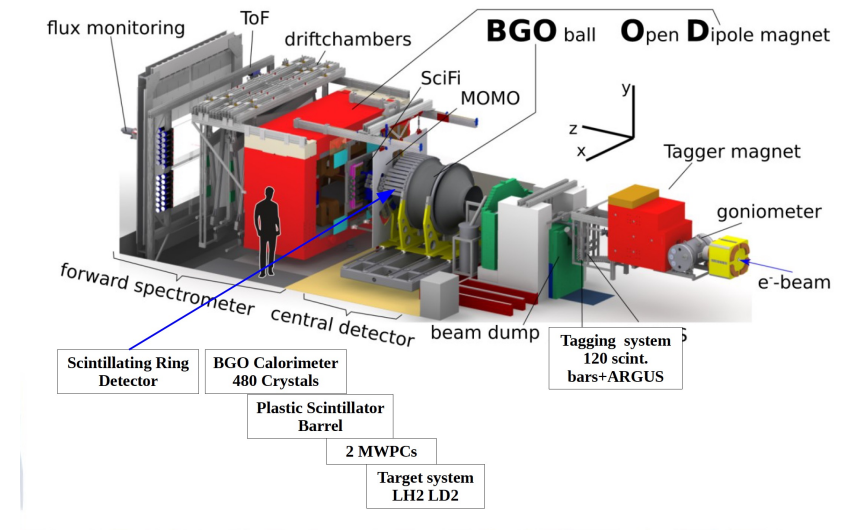
- Fascio di fotoni di energia 0.3-3.2 GeV
- Polarizzazione lineare e circolare del fascio
- Spokespersons: P. Levi Sandri (INFN-LNF) e Tom Jude

A2@MAMI (Mainz)

- Fascio di fotoni polarizzati di energia fino a 1.6 GeV
- Polarizzazione lineare e circolare del fascio
- Bersaglio polarizzato
- Spokespersons: P. Pedroni (INFN-PV) e A. Thomas

Obiettivi di fisica:

- Studio delle proprietà delle risonanze nucleoniche attraverso la fotoproduzione di mesoni con e senza stranezza, pseudoscalari e vettoriali con fasci e/o bersagli polarizzati



Publicazioni & Conferenze

Publicazioni

- 1) *Measurement of the $\gamma n \rightarrow K^0 \Sigma^0$ differential cross section over the K^* threshold*
EPJA 59 (2023) 254
- 2) *Coherent $\pi^0 \eta d$ photoproduction at forward deuteron angles measured at BGOOD*
arXiv:2405.09392, **submitted to PLB**
- 3) *$K^+ \Lambda(1520)$ photoproduction at forward angles near threshold with the BGOOD*
arXiv:2406.01121 (**To be submitted to EPJA**)

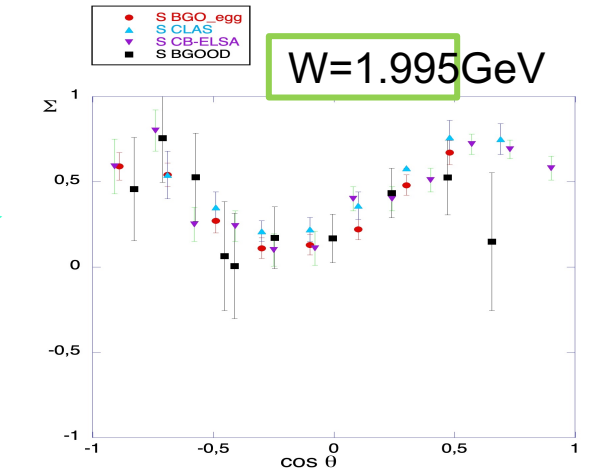
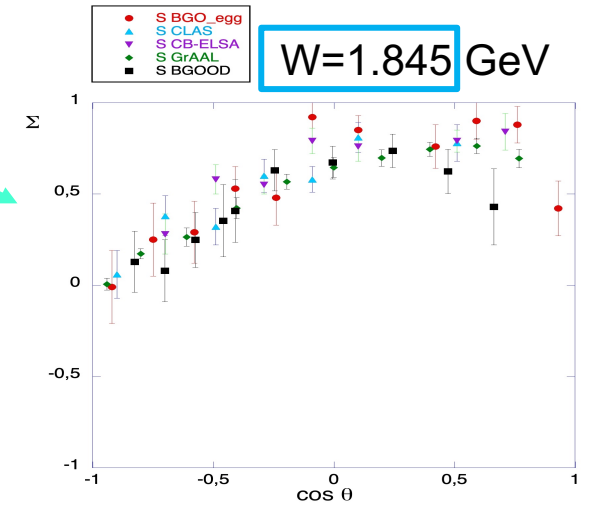
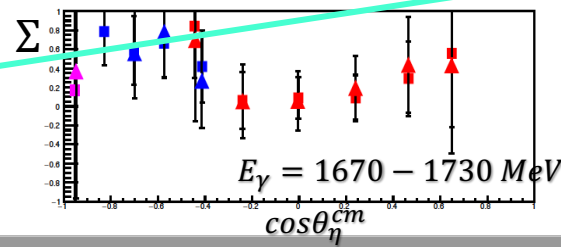
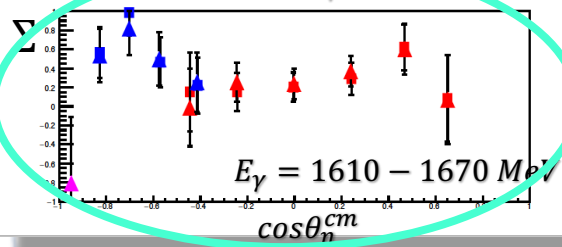
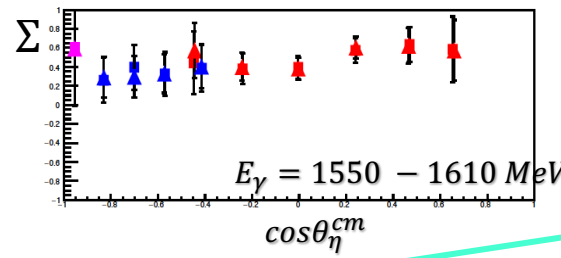
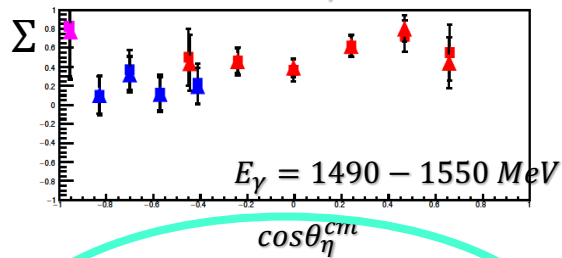
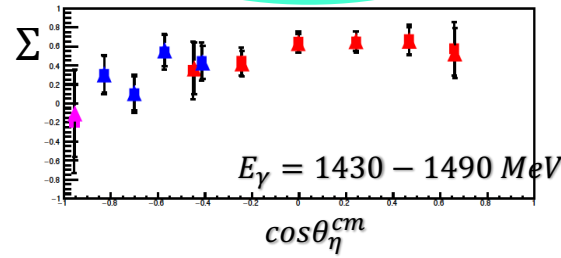
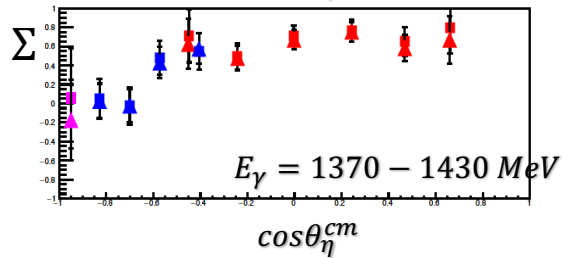
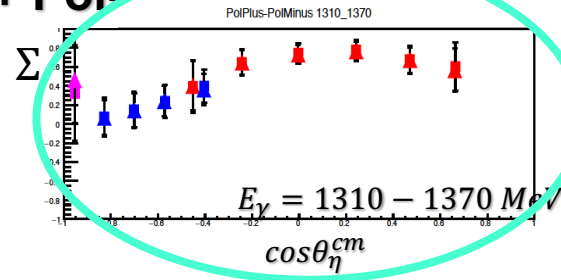
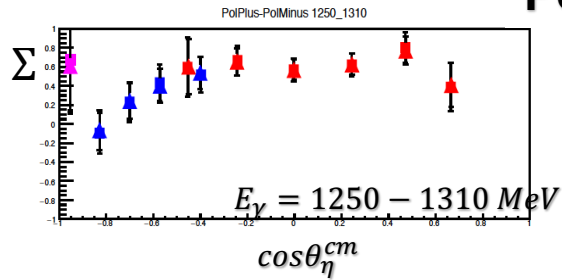
Conferenze

- 1) *The BGOOD experiment at ELSA - exotic structures in the light quark sector?*
T. Jude for BGOOD collaboration **EPJ Web of Conferences 291, 01004(2024), MESON2023**
- 2) *Evidence of a Di-baryon spectrum in coherent $\pi^0 \pi^0 d$ photoproduction at the BGOOD experiment,*
Hartmut Schmieden, **Hadron 2023**
- 3) *Σ beam asymmetry for η photoproduction off the proton at BGOOD*
A.Fantini NSTAR2024
- 4) *Σ beam asymmetry for η photoproduction off the proton at BGOOD*
A.Fantini Exotic Multi-Quark States and Baryon Spectroscopy Workshop

.....

Risultati $\gamma p \rightarrow \eta p$ – Asimmetrie di fascio vs $\cos\theta_{CM}$

Pol+Pol-



Attività BGOOD

-Periodo giugno 2023-giugno 2024:

- **Agosto-2023:** Sostituzione della cella del bersaglio (passaggio da 11cm a 6cm) e manutenzione del sistema criogenico con sostituzione dell'absorber e delle componentistiche obsolete o deteriorate
- **Sett-2023:** Presa dati interrotta dopo una settimana per problemi al klystron di ELSA. Intervento di manutenzione periodica di uno dei crate VME del BGO
- **Nov.-Dic. 2023:** presa dati di 2 settimane annullata per vari problemi all'acceleratore Intervento di manutenzione periodica del secondo crate VME del BGO
- **Feb-Mar 2024:** Presa dati di 2 settimane con bersaglio di protone (H liquido)

Attività prevista 2024-2025

- **Luglio 2024:** Presa dati di 2 settimane su deuterio bersaglio 6 cm per incrementare la statistica di fotoproduzione di η ed η' (in corso)
- **Sett-2024:** Presa dati di 2 settimane su deuterio bersaglio 6 cm per incrementare la statistica di fotoproduzione di η ed η'
- **Nov.-Dic. 2024:** presa dati di 2-3 settimane bersaglio 6 cm (in funzione della disponibilità di fascio)
- **2025:** prese dati su bersaglio di idrogeno/deuterio (bersaglio 6cm) per migliorare la risoluzione nella misura di canali completamente neutri

| ANAGRAFICA MAMBO 2025 (TOT FTE 2.6) | | | | |
|--|------------------|---------------------------------|------------|-------------|
| cognome | contratto | profilo | aff | perc |
| Di Salvo Rachele Anna | Dipendente | Primo Ricercatore | 3 | 90% |
| Fantini Alessia | Associato | Incarico di Ricerca scientifica | 3 | 70% |
| Romaniuk Mariia | Associato | Scientifica Enti stranieri | 3 | 100% |

| PREVENTIVI MAMBO 2025 | |
|---|--------------|
| Missioni | |
| 1.5 MU x 2.6 FTE = 18k€ a Bonn per Presa Dati + Manutenzione apparato calorimetro BGO-Target-MRPC | 18 K€ |
| Trasporti | |
| Trasporto Materiale da Roma a Bonn e viceversa | 1.5 K€ |
| Manutenzione | |
| Manutenzione/ riparazione schede HV/Mixer CAEN | 4.0 K€ |
| Consumo | |
| Metabolismo | 0.5 K€ |
| Totale Richieste | 24 k€ |

$$\text{valutazione costo } MU(\text{Mese Uomo}) = 30 \text{ gg} \times 155 \frac{\text{€}}{\text{die}} + 2 \text{ viaggi} \times 0.4 \text{ k€}$$

JLAB 12

Anagrafica – JLAB12 Roma Tor Vergata

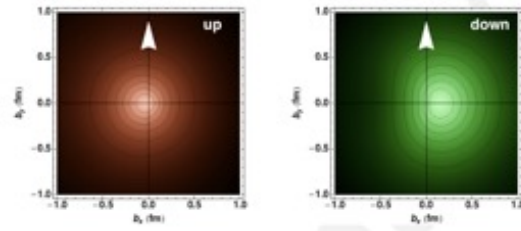
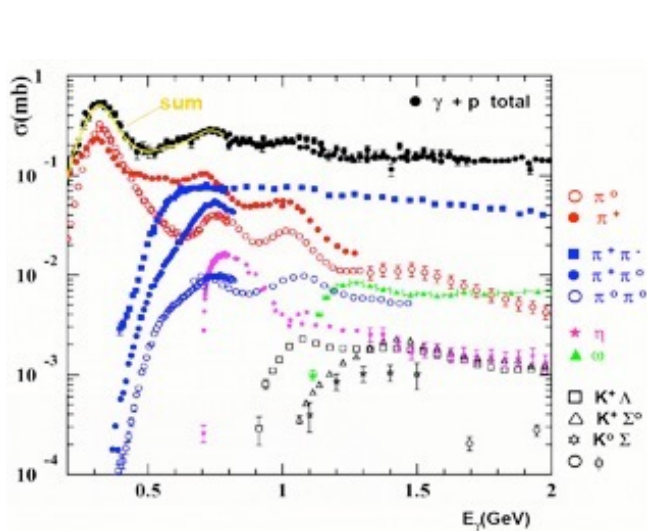
| cognome | nome | contratto | profilo | aff | perc |
|--------------------------|--------------|------------|------------------------------------|--------|---------|
| D'Angelo | Annalisa | Associato | Incarico di Ricerca scientifica | 3 | 50% |
| Lanza | Lucilla | Associato | RTDa | 3 | 70% |
| Sidoretti | Elena | Associato | Dottoranda | 3 | 100% |
| Rizzo | Alessandro | Associato | Scientifica Dipendenti altri enti | 3 | 100% |
| | | | | Totale | 3.4 FTE |
| Personale Tecnico | | | | | |
| Nobili | Giovanni | Dipendente | Collaboratore Tecnico E.R. | 3 | 50% |
| Pecchi | Daniele | Associato | Associazione Tecnica | | 30% |
| Reali | Enzo | Associato | Incarico di Collaborazione Tecnica | 2 | 30% |
| Tusi | Enrico Maria | Associato | Incarico di Collaborazione Tecnica | | 30% |
| | | | | Totale | 1.4 FTE |

Percentuale di partecipazione $3.2 \text{ FTE} / 4 \text{ RIC} = 85\%$

JLAB12 Jefferson Laboratory at 12 GeV

Motivation. Photo- and electro-production reactions on nucleons and nuclei with polarized beams and targets for:

- ✓ Hadron spectroscopy
- ✓ Nucleon Structure
- ✓ HPS – Heavy Photon Search & BDX (Beam Dump Experiment)



Bari, Brescia, Cagliari, Catania, Ferrara, Genova, LNF, LNS, Padova, Pavia, Roma1, Roma Tor Vergata, Torino
 Thomas Jefferson National Accelerator Facility – Virginia, USA

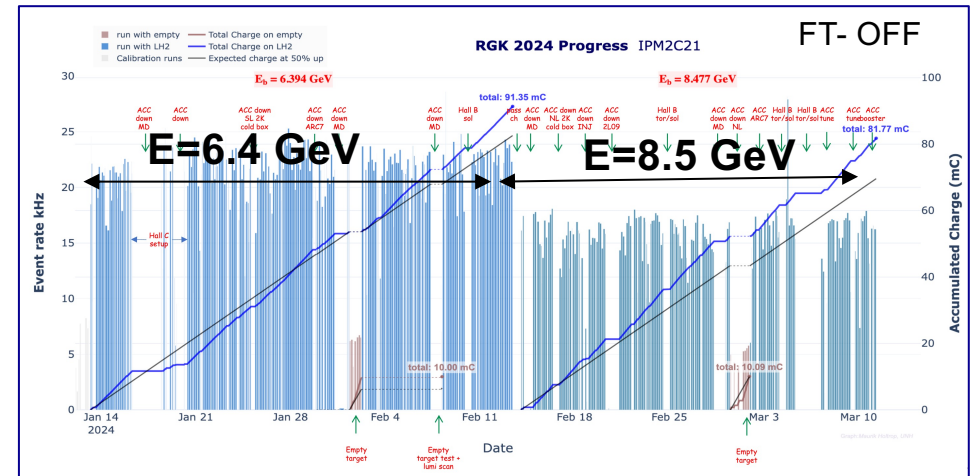
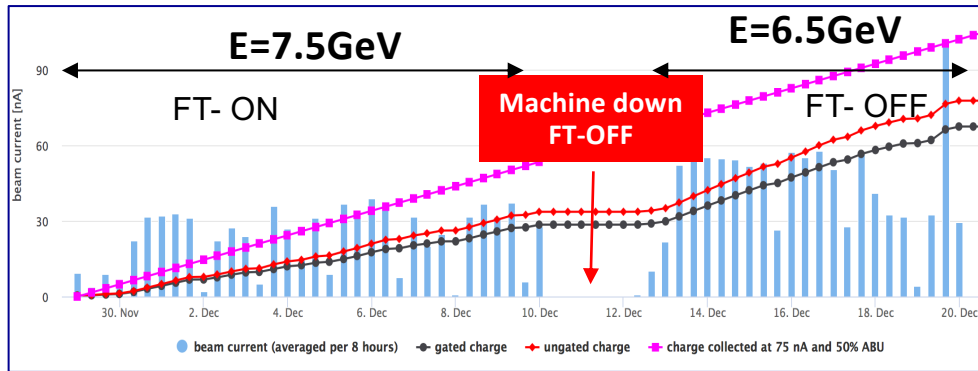
People: 45 researchers, (24,53 FTE) + 7 Technological Res. (3 FTE) + 10 technical staff

Data taking 2024-2032@ JLAB, Virginia

Run Group K Production

Fall 2018

SPRING 2024



45mC of accumulated charge

| Fall 2018 | | |
|-------------|--------------|------------------|
| Beam Energy | Beam Current | Collected Events |
| 7.5 GeV | 35 nA | 3.5 G |
| 7.5 GeV | 45 nA | 4.3 G |
| 6.5 GeV | 60 nA | 7.8 G |

EVENTS
15.6 G

Fall 2018

X4 more statistics: 50% of total assigned

193mC of accumulated charge

| Spring 2024 | | |
|-------------|--------------|------------------|
| Beam Energy | Beam Current | Collected Events |
| 6.4 GeV | 65 nA | 38.3 G |
| 8.5 GeV | 75 nA | 21.7 G |

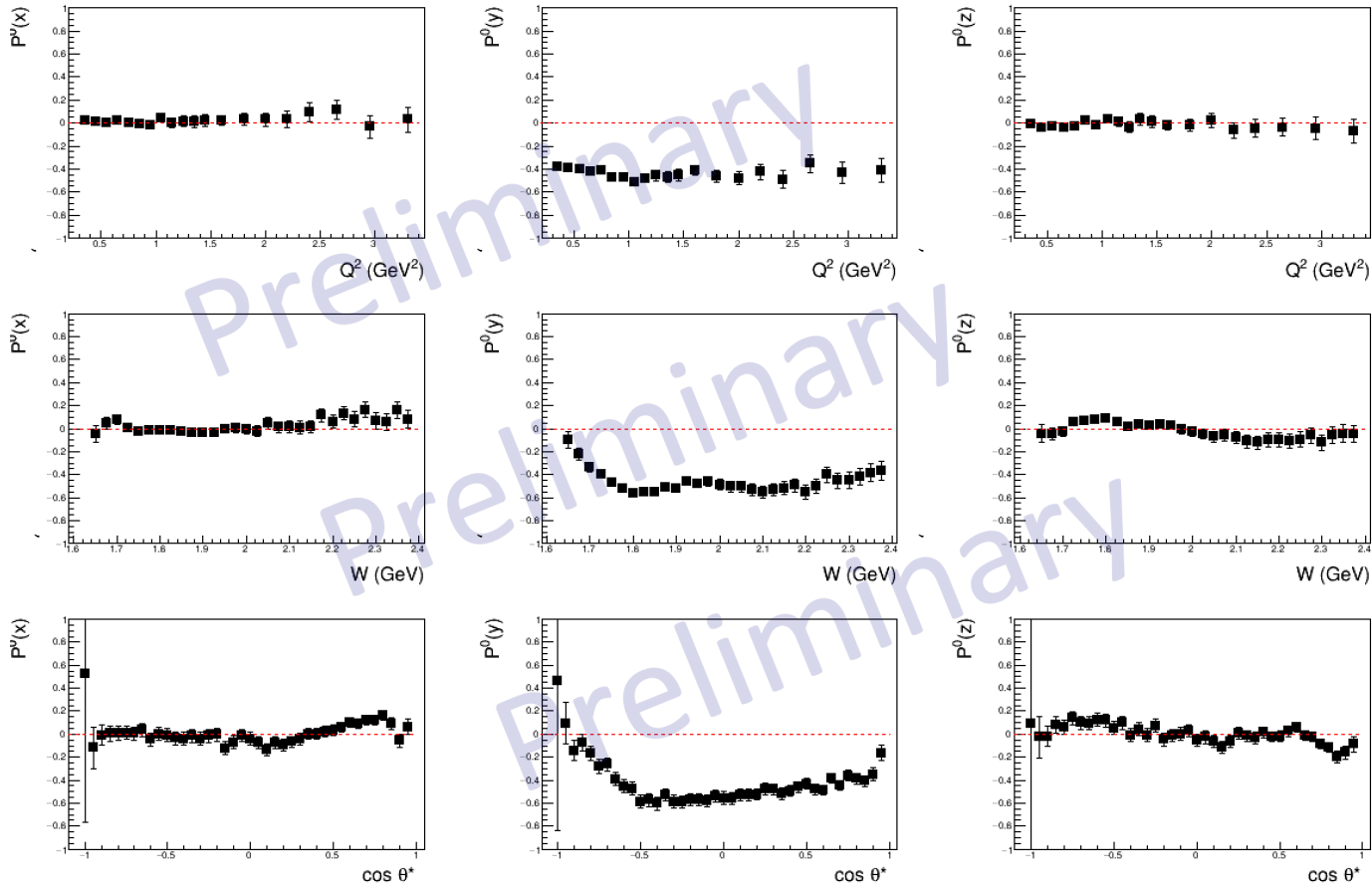
EVENTS
60 G

SPRING 2024

K⁺Y Induced Polarization CLAS12



$$\frac{N^+ - N^-}{N^+ + N^-} = \frac{\nu_Y \alpha P_Y}{2}, \nu_Y = 1 \text{ or } \nu_Y = -0.256, \alpha = 0.732$$



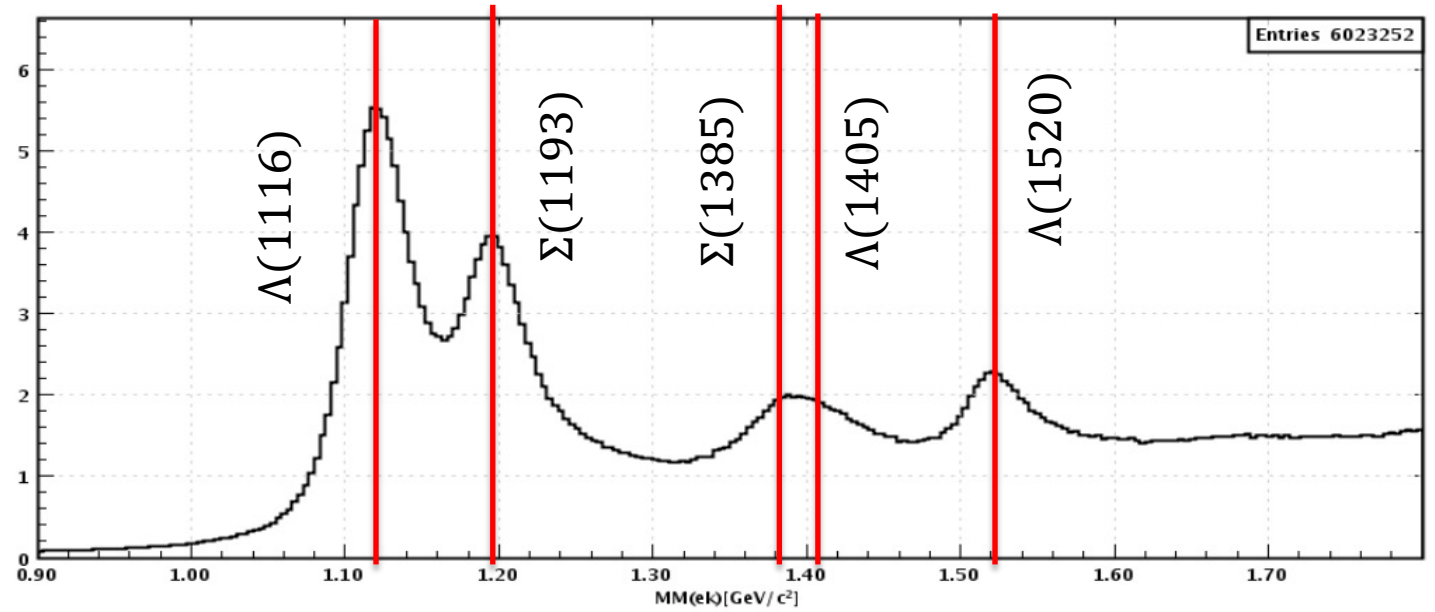
x and z components still not fully compatible with 0 as expected from theory

The analysis will be improved once the **Spring 2024** data will be available for analysis

By Lucilla Lanza

$\Lambda(1520)$ electroproduction

Other channels could be exploited as final states for possible new resonances..



 $\Lambda(1520)$ arises as a separate structure

The existence of several non-strange N^* resonances with significant ($\sim 5\%$) branching ratios into the $K^+ \Lambda(1520)$ decay channel has been predicted

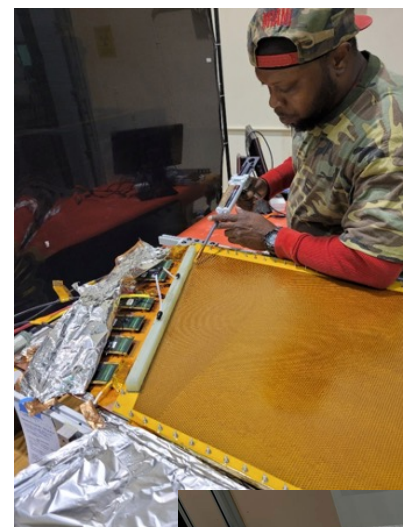
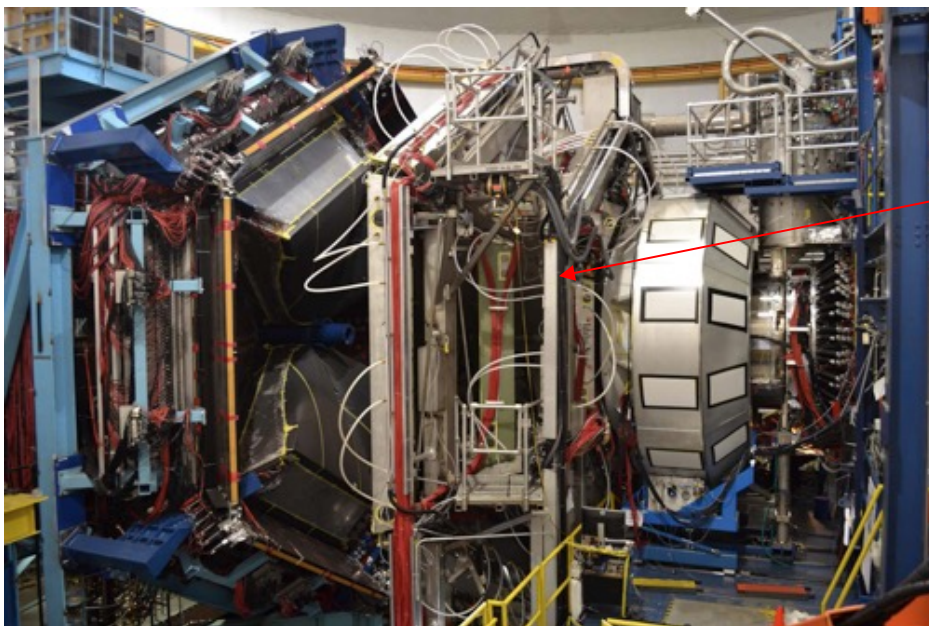
→ S. Barrow et al., CLAS Coll., Phys.Rev.C64:044601,2001

→ Simon Chapstick and W. Roberts, Phys. Rev. D **58** 074011

CLAS12

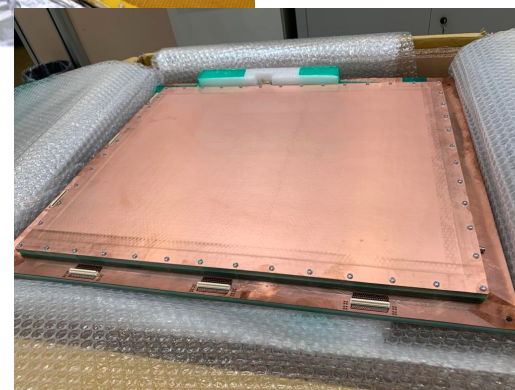
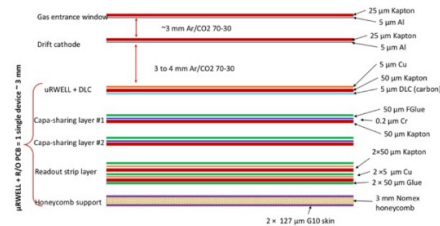
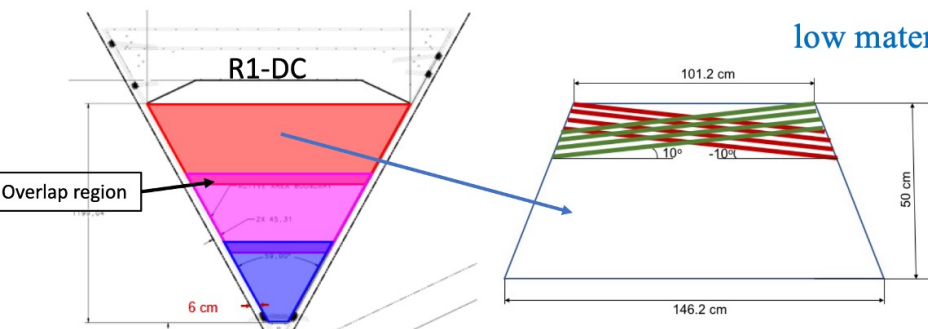
High Luminosity Upgrade:
 μ -Rwell tracking detector

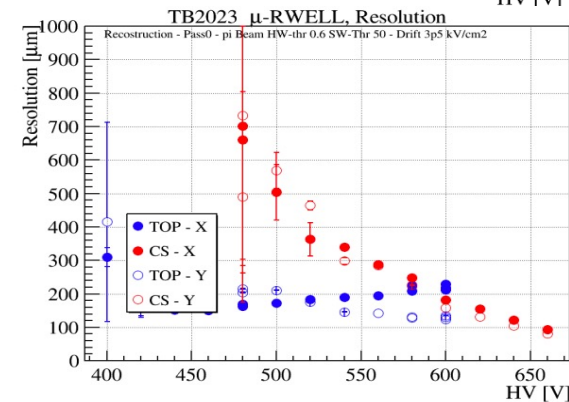
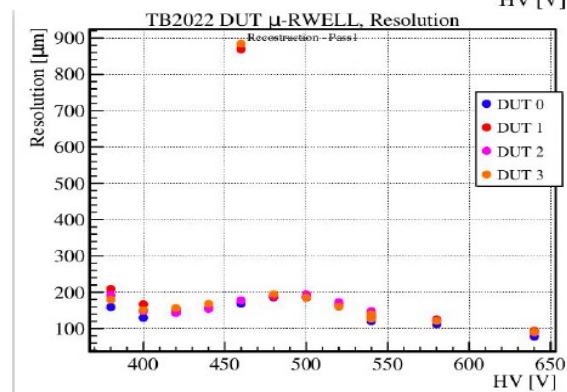
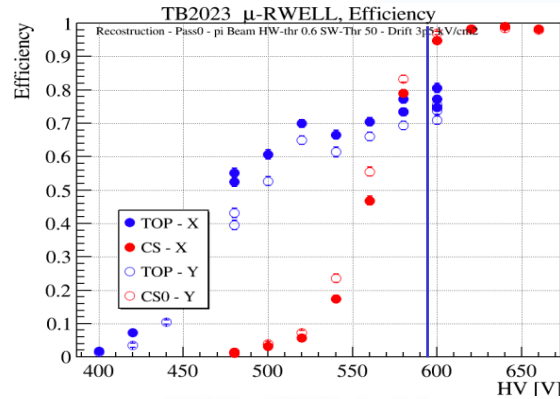
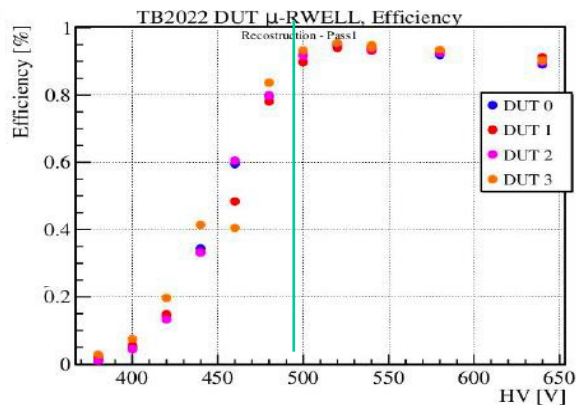
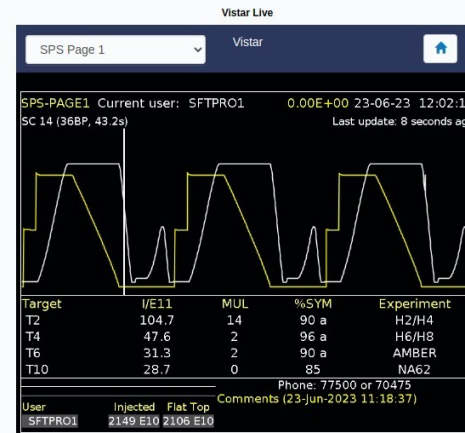
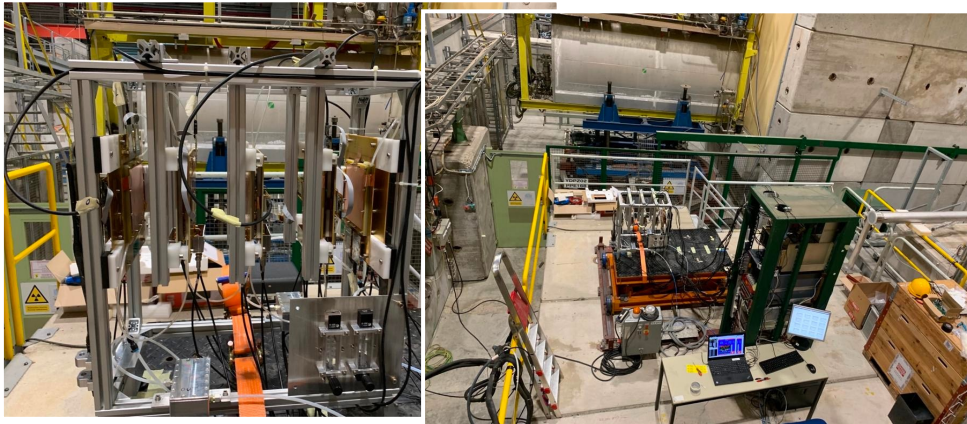
To be positioned in front of the drift chambers



Jlab prototype

INFN prototype





1D pitch 0.78 mm

Reference performances:

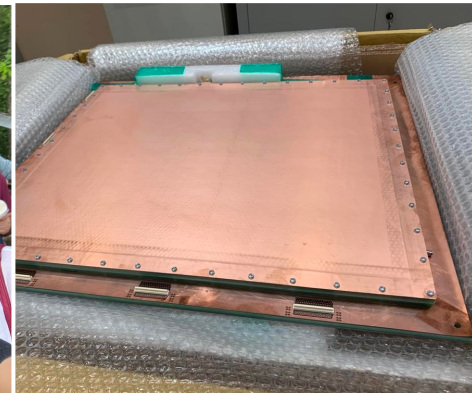
- 96% efficiency
- 120 μ m resolution

CS pitch 1.2mm

- Due to the charge spread the **working point is shifted to high voltage/gain**
- Spatial resolution improves at high gain reaching **150 μ m** with a strip pitch of 1.2 mm

Top-read-out pitch 0.78 mm

- low-voltage/gain operation but **low efficiency level (80%)** due to the geometrical dead zone on the segmented amplification stage



2D readout R&D strategy and Instrumentation

- 2 50x50 cm² 2D prototypes with GEM pre-amplifier, optimized 2D and CS readout
- X-Ray Gun with support and shielding structure – tagged DRD-1 item
- GEM - stretcher

SYNERGIES

- Forward tracking disks for ePIC-EIC
- Future recoil detector for RG-H (Ferrara)
- DRD – 1 initiative

On-going collaboration with INFN Catania and INFN Genova

- Construction of a cosmic-ray/test beam stand with plastic scintillators triggers (Catania)
- Test of new readout electronics based on VMM3 chip (Genova)

Richieste Strumenti ed Apparti Roma Tor Vergata

| Item | Costo K € |
|---|-----------|
| 2 fogli GEM Layout 50x50 incluso design e tooling | 5 |
| 2 cornici in peek 50cm x50 cm | 3 |
| Tubo a Raggi X | 9.5 |
| Materiale per supporto e schermaggio DRD-1 item | 8.5 |
| Strumentazione per incollaggio GEM su frame in peek | 4 |
| Gas premiscelato Ar:CO ₂ :CF ₄ (45:15:40) e 2 bombole Azoto | 3 |
| 10 Misuratori di tensione | 10 |
| Lastra in Alluminio rettificato e componenti meccanici per tendi-GEM | 3 |
| Totale | 46 |
| Missioni | |
| Missioni per turni di misura CLAS – Hall-B | 18.5 |
| Missioni per test beam al CERN (sub giudice?) | 6.5 |
| Missioni per riunioni CT/GE | 3 |
| Totale Missioni | 28 |
| Totale richieste | 74 |

FOOT



FOOT Purposes

$p + C, O, N$
 $C + C, O, Si$
 $Fe + C, Si, Al$

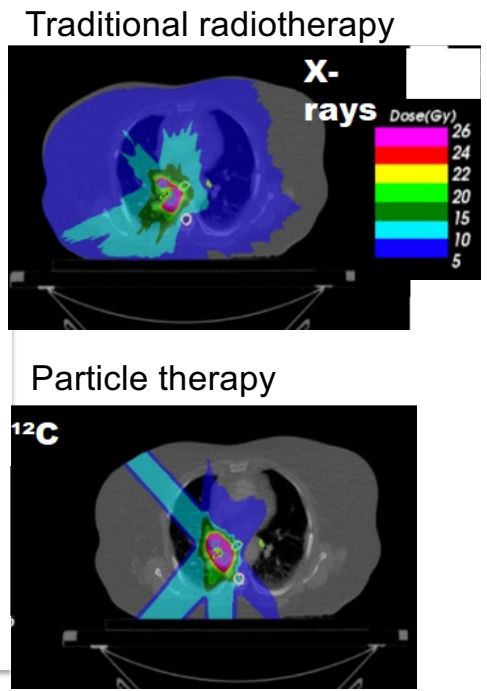
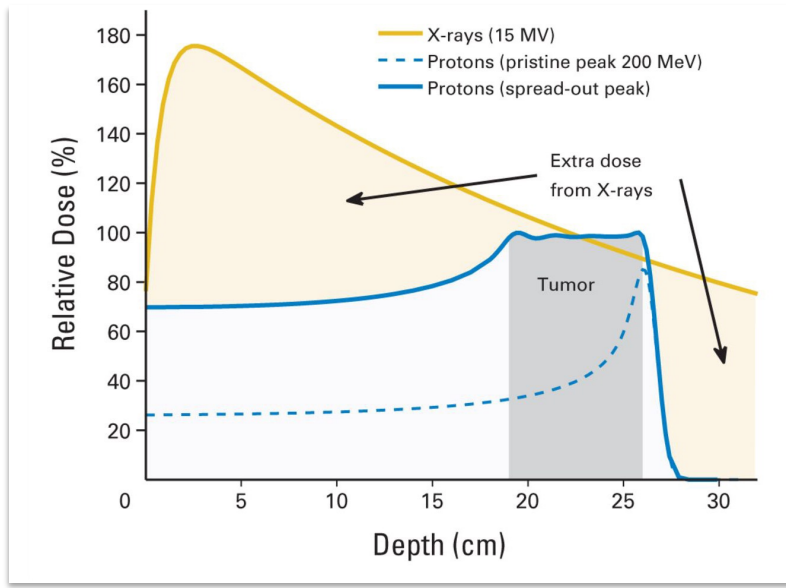
$$\frac{d\sigma}{d\Omega}, \frac{d\sigma}{dE_{kin}}$$

Goal accuracy <5%

Measurement of fragmentation cross sections for **Hadrontherapy** and **deep space radioprotection**

$80 \text{ MeV/N} < E_{kin} < 400 \text{ MeV/N}$

$0.5 \text{ GeV/N} < E_{kin} < 2 \text{ GeV/N}$



Spacecraft shielding Radio-protection in Space



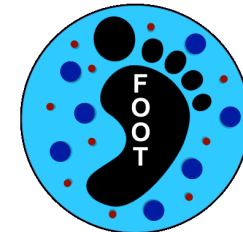
FOOT Highlight 2023-2024



Main achievements since june 2023

- ✓ Magnet: arrived in LNF by beginning of september, measured almost immediately and put along the beam line in october 23.
- ✓ Intermediate Tracker (IT): mounted, tested at BTF in september 23 and inserted in the electronic set-up.
- ✓ Calorimeter completed. First round of calibration of all crystals in CNAO 2023. Gaining experience. Better mechanical fixing of modules under way.
- ✓ Several samples acquired at CNAO oct/nov 23 runs: detector calibration (calorimeter, vertex, IT, MSD), data for physics with e-setup and emu-set-up
- ✓ For optimal data acquisition the beam rate was on the «low» side: 200 Hz Beam and detector constraints.
- ✓ We won a MAECI project (MOFFIITS): Oxygen fragmentation on Carbon (GSI) total 800k€, 200k€ cash for INFN!
- ✓ At least 4 projects are synergic with FOOT: Several detector activities (New Vertex, New TW)
- ✓ Results on two samples taken at GSI are about to be published
- ✓ Currently we're preparing for the GSI 2025 data taking with ^{16}O beam, 500 MeV/N (feb-jun TBD)

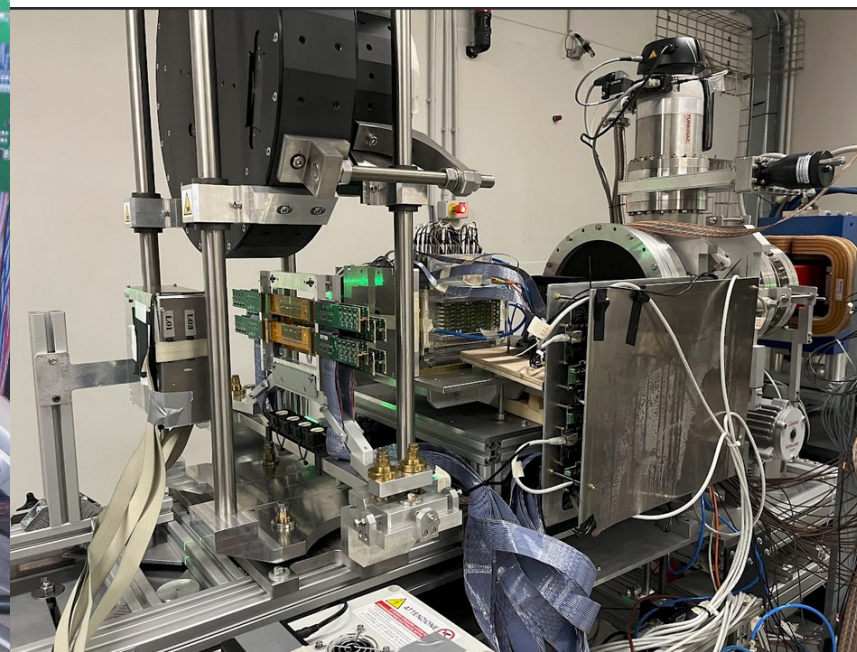
Magnet and Intermediate Tracker!



BTF test



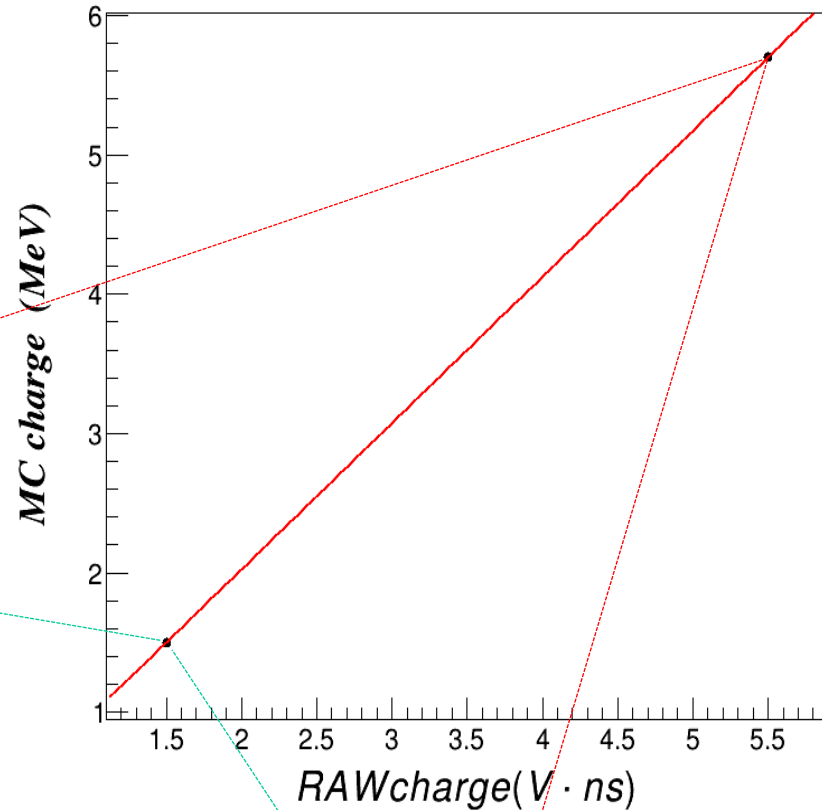
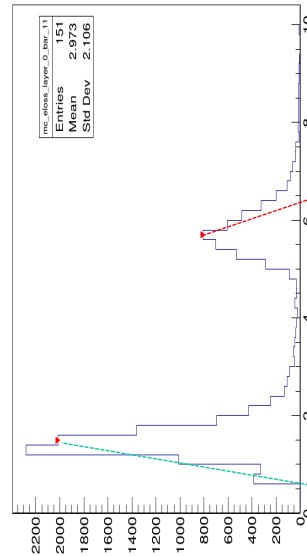
CNAO set-up



FOOT experiment

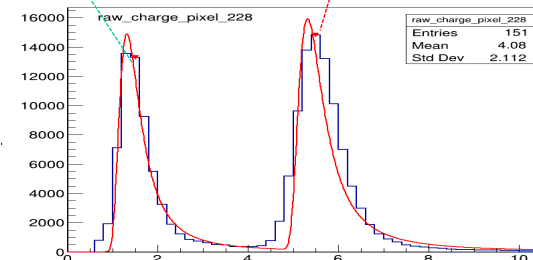
Calibration of the TOF-Wall detector – HIT2022 data

- The two peaks of the raw energy loss distribution are automatically fit with a Landau curve and the mean value of both raw charge peaks are extracted
- The mean values of both MC energy loss peaks are extracted with the support of the ROOT Tspectrum class



- Linear fit: $\mu(\Delta E_{MC}) = p_0 \cdot \mu(Q) + p_1$

- p_0 ($MeV/V \cdot ns$) represents the charge conversion factor between the MC and the experimental data
- p_1 has the dimensions of MeV



RIPTIDE project

Prototype construction and tests

RIPTIDE is a Recoil Proton Track Imaging (RPTI) detector for fast neutrons aiming at measuring with good efficiency all kinematic properties (energy and momentum) of incoming neutrons retrieving their trajectory from both single n-p scattering (when the primary vertex of neutron trajectory is known e.g. point-like target in fixed-target experiments) and double or multiple n-p scattering (general case) in the detector active volume.

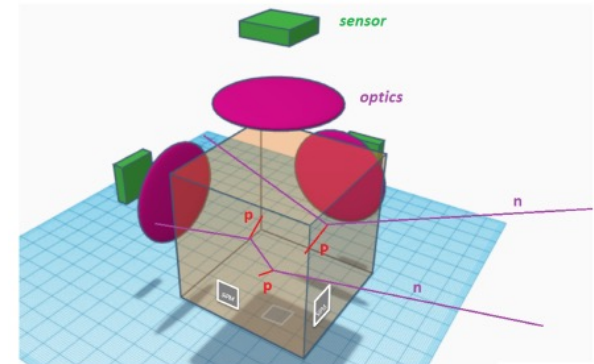
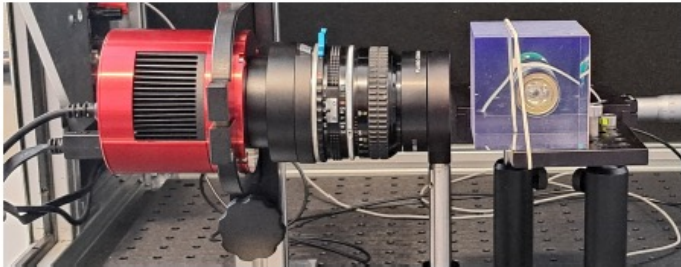
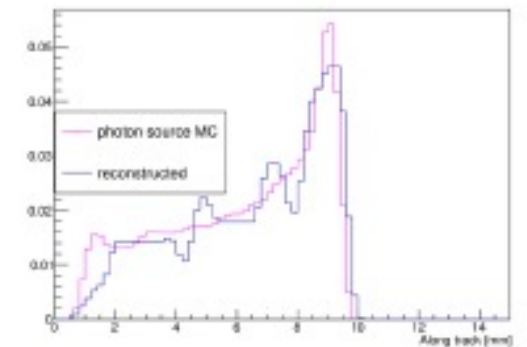
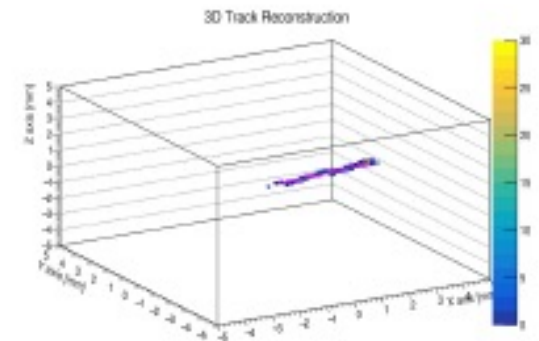
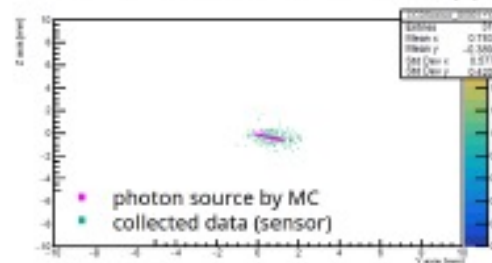
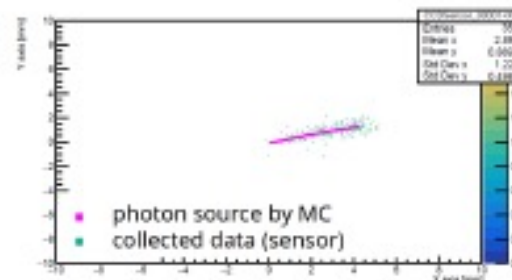


Figure 1: RIPTIDE working principle.



RIPTIDE setup with astronomy imaging camera and on-the-shelf optics.

Data on two sensor faces, i.e. 2D projections (left). Reconstructed track of a 30MeV proton (top right). Reconstructed vs true photon emission along the track of a 30MeV proton (bottom right).



Papers published in 2023

- Kraan A.C. et al., Calibration and performance assessment of the TOF-Wall detector of the FOOT experiment, NIM A, 10.1016/j.nima.2022.167615
- Silvestre G et al, Characterization of the Microstrip Silicon Detector for the FragmentatiOn Of Target experiment, NIM A, 10.1016/j.nima.2022.167717
- Zarrella R. et al, Nuclear fragmentation cross section measurements with the FOOT experiment, proc. 10.1051/epjconf/202328410001
- Ridolfi R., Nuclear fragmentation cross section measurements with the FOOT experiment, EPJ Web conf., 10.1051/epjconf/202329008006
- Ubaldi G. et al, The FOOT experiment: A first measurement of nuclear fragmentation cross section for hadrontherapy, NC, 10.1393/ncc/i2023-23105-y
- Galli L., The fragmentation trigger of the FOOT experiment, NIM A, 10.1016/j.nima.2022.167757

3 papers in writing stage

19 Bachelor and Master theses

1 PhD thesis

8 talks at conferences (without proceedings)

**MAECI PROJECT:
Measuring Oxygen Fragmentation For Improved Ion Therapy Strategies
(MOFFIITS)**



Call for cooperation between Italian research groups and German infrastructures

Max requests: 200k€ to MAECI + 200k€ Italian agency +

200k€ German funds+ 200k€ German infrastructure

Submitted a FOOT-like program for 32h of beam time with ^{16}O at GSI.
Energy range: 400-700 MeV. Detector: electronic & emulsions

FUNDED for 193 k€ to INFN, 193k€ to GSI

Data taking: second year (February-June 2025).

Programmi a «breve»

Downgrade delle misure al CNAO 2024: solo aspetti strumentali/calibrazioni (TofWall, Calorimetro, Tracking)

Stop di varie attività per prossimi concorsi INFN

Possibile presa dati a novembre/dicembre alla BTF per il nuovo VTX



Per settembre faremo una valutazione accurata delle necessità delle missioni e restituiranno subito i SJ che non verranno usati

Misure al GSI con fascio di ^{16}O a 500 MeV/c nella prima metà del 2025 (certo)

Presumibili misure al CNAO a fine 2025 (saranno messe SJ nei preventivi)

| ANAGRAFICA FOOT 2025 (TOT FTE 2) | | | |
|---|------------------|------------------|--------------|
| Persone | Profilo | Afferenza | perc. |
| Morone | PA, Incarico ric | CSN3 | 70% |
| Narici | PA, Incarico ric | CSN2 | 30% |
| Minniti | Rtdb, Associato | CSN3 | 100% |

| PREVENTIVI FOOT 2025 | |
|--|--------------------|
| Missioni | |
| General meeting di esperimento in Italia, presa dati al CNAO, presa dati al GSI, meeting per tracciatore n | (6+3sj)K€ |
| Consumo | |
| Metabolismo | 1 K€ |
| Totale Richieste | (7 +3sj) k€ |

ANAGRAFICA GRUPPO 3

fte-i_infn_roma2_csn3

| cognome | nome | modi | cont | profilo | stato | aff | EPIC | ERNA2 | FOOT | J_LAB12 | MAMBO | perc | tot |
|--------------------|----------------|------|------|------------------------------------|---------|-----|------|-------|------|---------|-------|--------------------------|------|
| Totale(FTE) | | | | | | | 2.80 | 0.30 | 2.00 | 4.60 | 3.90 | | 13.6 |
| Ammendola | Roberto | G2 | Dip | Tecnologo | Attivo | 5 | 20 | | | | | EPIC - 20% | 20 |
| Armonaite | Karolina | G1 | Ass | Scientifica Assegni non INFN | Scaduto | 2 | 20 | | | | | EPIC - 20% | 20 |
| Benkel | Bruno | G1 | Dip | Assegno di Ricerca | Scaduto | 3 | 100 | | | 0 | | EPIC - 100% JLAB12 - 0% | 100 |
| D'Angelo | Annalisa | G1 | Ass | Incarico di Ricerca scientifica | Scaduto | 3 | 50 | | | 50 | | EPIC - 50% JLAB12 - 50% | 100 |
| Di Salvo | Rachele Anna | G1 | Dip | Primo Ricercatore | Attivo | 3 | 10 | | | | 90 | EPIC - 10% MAMBO - 90% | 100 |
| Fantini | Alessia | G1 | Ass | Incarico di Ricerca scientifica | Scaduto | 3 | 30 | | | | 70 | EPIC - 30% MAMBO - 70% | 100 |
| Lanza | Lucilla | G1 | Ass | Scientifica Ricercatori/Professori | Scaduto | 3 | 30 | | | 70 | | EPIC - 30% JLAB12 - 70% | 100 |
| Minniti | Triestino | G1 | Ass | Scientifica Ricercatori/Professori | Scaduto | 3 | | | 100 | | | FOOT - 100% | 100 |
| Morone | Maria Cristina | G1 | Ass | Incarico di Ricerca scientifica | Scaduto | 3 | | 30 | 70 | | | ERNA2 - 30% FOOT - 70% | 100 |
| Narici | Livio | G1 | Ass | Incarico di Ricerca scientifica | Scaduto | 2 | | | 30 | | | FOOT - 30% | 30 |
| Nobili | Giovanni | G3 | Dip | Collaboratore Tecnico E.R. | Attivo | 3 | | | | 50 | 30 | JLAB12 - 50% MAMBO - 30% | 80 |
| Pecchi | Daniele | G3 | Ass | Associazione Tecnica | Scaduto | 3 | | | | 30 | 40 | JLAB12 - 30% MAMBO - 40% | 70 |
| Reali | Enzo | G3 | Ass | Incarico di Collaborazione Tecnica | Scaduto | 2 | | | | 30 | | JLAB12 - 30% | 30 |
| Rizzo | Alessandro | G1 | Ass | Scientifica Dipendenti altri enti | Scaduto | 3 | | | | 100 | | JLAB12 - 100% | 100 |
| Romaniuk | Mariia | G1 | Ass | Scientifica Enti stranieri | Scaduto | 3 | | | | | 100 | MAMBO - 100% | 100 |
| Salina | Gaetano | G1 | Dip | Dirigente di Ricerca | Attivo | 2 | 20 | | | | | EPIC - 20% | 20 |
| Sidoretti | Elena | G1 | Ass | Scientifica Dottorandi | Attivo | 3 | | | | 100 | | JLAB12 - 100% | 100 |
| Tusi | Enrico Maria | G3 | Ass | Incarico di Collaborazione Tecnica | Scaduto | 1 | | | | 30 | | JLAB12 - 30% | 30 |
| Vitali | Gianni | G3 | Ass | Associazione Tecnica | Scaduto | 3 | | | | | 60 | MAMBO - 60% | 60 |

Ricercatori: 13 (10.7 FTE) - Tecnologi: 1 (0.2 FTE) - Tecnici: 5

Richieste metabolismo DTZ3

| Sezione | nFTE | Coordinatore | Missioni | Consumo | Seminari | Pubblicazioni | Inventario | Totale NON missioni | TOTALE |
|---------|------|--------------|---------------------|---------|----------|---------------|--------------------------------|---------------------|--------|
| | | | $(fte*1.05+4)*0.57$ | FTE*0.5 | FTE*0.1 | FTE*0.2 | $(10/2.7971) * \ln(fte)^{1.5}$ | | |
| RomaTOV | 10,9 | 1 | 9 | 5,5 | 1 | 2 | 13 | 21,5 | 30,5 |